

**Class Outlines**  
**October 9 and October 11, 2001**

**October 9, 2001**

- I. Review (aspects of unemployment in U.S. economy)
- II. How are wages determined?
  - a. In some countries, wages are determined by collective bargaining either at a national level, industry level, or firm level. In the United States, collective bargaining plays less of a role. Collective bargaining is an example of an institutional difference between the U.S. and other countries. In spite of this and other institutional differences, there are at least two factors that most countries have in common with respect to wage determination.
    - i. Workers are typically paid more than their reservation wage. The *reservation wage* is the lowest wage that makes a worker just indifferent between working and staying unemployed.
    - ii. The lower the unemployment rate, the higher the wage rate. In other words, there is an inverse relationship between wages and unemployment.
  - b. Theories related to wage determination.
    - i. Bargaining. Bargaining power depends more or less on two factors.
      - 1. How easily can a worker find a job if he or she becomes unemployed?
      - 2. How easily can a firm replace a given worker?
      - 3. Because it can be costly to replace workers, firms may desire to decrease turnover. To decrease turnover, firms may pay workers more than the wage rate that makes them just indifferent from becoming unemployed. This helps explain why workers are typically paid more than their reservation wage.
      - 4. As unemployment decreases, firms will find it more difficult to replace existing workers. In addition, workers will find it easier to move from one job to another. This helps explain why wages and unemployment tend to be negatively related.
    - ii. Efficiency wages. Firms desire to keep operations running efficiently. It is often expensive to train workers, and wages may be an important incentive to existing workers. This helps explain, again, why workers may be paid more than their reservation wage.

c. Unemployment and Wages, a closer look. *The Wage Setting equation.*

- i. Wages are used to purchase goods and services. When an employee negotiates their wages, they will insist on higher wages when prices are expected to rise. This occurs because employees will lose out if they have negotiated a fixed wage, and then prices increase. Thus, as the expected price level (denoted  $P^e$ ) increases, employees will negotiate a higher wage rate.
- ii. We have seen above that wages and unemployment are inversely related.
- iii. There are other things that can affect wages, such as unemployment compensation and skill levels. We are primarily interested in studying the effects on unemployment, so we simply acknowledge that there are other factors that can affect wage rates. We denote these other factors with the letter  $z$ , and assume that wages are directly related to  $z$  (for example, as unemployment compensation increases, it is easier for an employee to become unemployed. This improves their bargaining position and we would expect they would be able to negotiate a higher wage).
- iv. These three aspects of the model can be combined to yield the following *wage setting equation*
  1.  $W = P^e f(u, z)$ .

d. *The price setting equation.*

- i. The above indicates the value of wages when prices are taken as given. We now wish to do the opposite, so as to be able to define equilibrium. Firms use labor to produce goods and services. *The production function* gives the relationship between output and the factors of production.
- ii. Assumptions:
  1. Production is only a function of labor.
  2. Production is related to labor one for one (e.g. the relationship is linear). This also implies that labor productivity (the ratio of output to labor) is equal to 1. Together, this implies the following production function:
    - a.  $Y = N$ , where  $N$  denotes employment.
- iii. How do firms maximize profits by selecting labor amounts?
  1. Profit maximizing rule:  $MRP = \text{wage}$ . To maximize profits, firms will hire workers so long as they generate more revenue than the amount they must be paid. Mathematically, the additional revenue generated from hiring one more worker is also known as *marginal revenue product*. It is defined as the change in total

revenue ( $\Delta TR$ ) divided by the change in labor ( $\Delta N$ ). Of course, the additional amount that must be paid to a worker is simply the wage.

2.  $MRP = (\Delta TR) / (\Delta N) = [(\Delta TR) / (\Delta Y)] * [(\Delta Y) / (\Delta N)]$ . The first quantity in brackets is also known as marginal revenue. The second quantity is known as marginal product. Thus, marginal revenue product is equal to marginal revenue times marginal product.
3. If  $Y=N$ , then the additional production generated from hiring another worker is constant and equal to one. Thus, marginal product, in OUR model, is simply equal to 1. The profit maximizing decision tells us that firms should set marginal revenue equal to the wage rate.
  - a. Case 1. All firms are perfectly competitive: Recall from your microeconomics class, that a purely competitive firm can sell as much output as they want at existing prices. For the purely competitive firm, therefore, marginal revenue is simply equal to the price. Thus, the profit maximizing decision for wage determination is:  $P=W$  (set prices equal to the wage rate).
  - b. Case 2. Not all firms are perfectly competitive. Some firms will charge a price higher than the wage rate. In other words, they will mark up their prices so that they are higher than their costs so as to make economic profit. Let  $\phi$  denote the percent by which firms mark up their costs. Then the price setting equation is
    - i.  $P=(1+\phi)W$ .
    - ii. e.g If  $\phi=.5$ , then firms charge a price that is 1.5 times the wage rate they pay. Note that if the mark up over cost is zero, then firms charge a price equal to the wage rate (which is the purely competitive case).

- e. Equilibrium in the labor market, and the natural rate of unemployment.
  - i. The wage setting and price setting equations are as follows:
    1. (WS):  $W=P^e f(u,z)$
    2. (PS):  $P=(1+\phi)W$
  - ii. **The natural rate of unemployment** is the unemployment rate that results when the expected price level corresponds to the actual price level. If the actual price level is equal to the expected price level, then we replace  $P^e$  in the wage setting equation by  $P$ . If we then divide both sides by  $P$ , we get the following wage setting equation. (Note, the unemployment

rate corresponds to the natural rate of unemployment if the expected price level corresponds to the actual price level. I have thus replaced  $u$  with  $u_N$ ).

1.  $W/P=f(u_N,z)$ .

- iii. If we first divide both side of the price setting equation by  $(1+\phi)$ , and then divide both sides by  $P$ , we get the following new price setting equation.

1.  $W/P=1/(1+\phi)$

- iv. In equilibrium, these equations must be consistent with each other. Thus, equilibrium can be found by setting the equations equal to each other:

1.  $f(u_N,z)=1/(1+\phi)$

- f. We plotted each equation with the real wage on the y-axis, and unemployment on the x-axis. Suppose the firm's mark up over cost increased. Then,  $1/(1+\phi)$  decreases, and employees are paid a lower real wage. In response, the natural rate of unemployment increases.

## October 11, 2001

### I. Review

### II. From unemployment to output.

- a. To set up aggregate demand and aggregate supply, we must relate output to prices. We can use our relationship between prices and unemployment to say something about prices and output.
  - i.  $u=U/L$  (The unemployment rate is equal to the total number of unemployed workers divided by the labor force).  $U=L-N$  (the total number of unemployed workers is equal to the total number of workers in the labor force minus those who are employed). Thus,
    1.  $u=(L-N)/L=1-N/L$ .
    2. From the production function,  $Y=N$ . Thus,  $u=1-Y/L$ .
    3. The output level that corresponds to the natural rate of unemployment is also known as *full employment output or potential GDP*. Denote full employment output by  $Y_{FULL}$ .
    4. Given the relationship between output and unemployment, we can rewrite the wage setting equation as follows:
      - a.  $W=P^e f(1-Y/L,z)$ .
    5. The new equilibrium condition in the labor market *at full employment* becomes,
      - a.  $F(1-Y_{FULL}/L,z)=1/(1+\phi)$ .

### III. Aggregate supply.

- a. We will find aggregate supply by finding equilibrium in the labor market. Our new wage setting and price setting equations are written as follows:
  - i. (WS):  $W=P^e f(1-Y/L)$
  - ii. (PS):  $P=(1+\phi)W$
- b. Equilibrium results when these equations are consistent with each other. If we replace the wage in the price setting equation with the wage from the wage setting equation, we get the following *aggregate supply* relationship:
  - i.  $P=(1+\phi)P^e f(1-Y/L)$
- c. Note:
  - i. As the expected price level increases, actual prices increase resulting in a shift in the aggregate supply curve.
    1. Why?
      - a. As the expected price level increases, from wage setting, wages increase. As wages increase, from price setting, firms will increase their prices.
  - ii. As output increases prices increase. There is a negative relationship between prices and unemployment. There is also a negative relationship between unemployment and output (the unemployment rate is equal to 1 *minus* output divided by the labor force). Thus there is a positive (two negatives do in fact create a positive when multiplied by each other) relationship mathematically between output and prices according to our AS relationship.
    1. Why intuitively?
      - a. As output increases, firms must expand production. From the production function we must hire more workers. Since nothing has happened to the labor force, more workers imply that the unemployment rate decreases. As unemployment decreases, wages increase. Higher wages lead to higher prices.
- d. Aggregate supply and the expected price level.
  - i. The full employment output level is on the aggregate supply curve. At full employment, actual prices equal expected prices. Thus, the aggregate supply curve **MUST** pass through the expected price level.
  - ii. If  $P > P^e$ , then firms can charge a higher price for their output than they had planned to relative to wages (wages are set

according to expected prices). Since firms are making higher than expected profits they expand output.

- iii. If  $P < P^e$ , firms are paying their employees a higher price than what they are getting relative to their output. It stands to reason that firms will reduce output. This helps explain the positive relationship between prices and output in the context of aggregate supply.

#### IV. Aggregate demand

- a. Goal: We desire to plot what happens to equilibrium output using our IS/LM curve analysis when prices change.
- b. Prices and the real stock of money.
  - i. As prices increases, the real stock of money declines. This has the same effect as contractionary monetary policy. We recall that contractionary monetary policy causes the LM to shift to the left, and output fall. If prices decrease, output expands. We can put these effects together to see that aggregate demand is negatively related to prices.